

*Operation Manual for*  
*Grad-01-1000L*  
*Single Axis Fluxgate Magnetic Gradiometer*



**Bartington**<sup>®</sup>  
Instruments

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## 1. How to Use this Manual

This manual provides the information necessary to help customers connect and operate the Grad-01-1000L Single Axis Fluxgate Magnetic Gradiometer from Bartington Instruments.

It should be read in conjunction with datasheet DS0060, available from [www.bartington.com/product-brochures-gradiometers](http://www.bartington.com/product-brochures-gradiometers).

### 1.1. Symbols Glossary

The following symbols used within this manual call your attention to specific types of information:



**WARNING:** Indicates a situation in which serious bodily injury or death could result if the warning is ignored.



**Caution:** Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.



Identifies items that must be disposed of safely to prevent unnecessary damage to the environment.

**Note:** A note provides useful supporting information and sometimes suggests how to make better use of your purchase.

## 2. Safe Use



**WARNING:** This product is not qualified for use in explosive atmospheres or life support systems. Consult Bartington Instruments for advice.

## 3. Introduction

The Grad-01-1000L is a high stability fluxgate gradient sensor for integration in multi-sensor instruments. Each sensor contains electronics and non-volatile memory for calibration data storage, and can be operated independently, over long cables, if required.

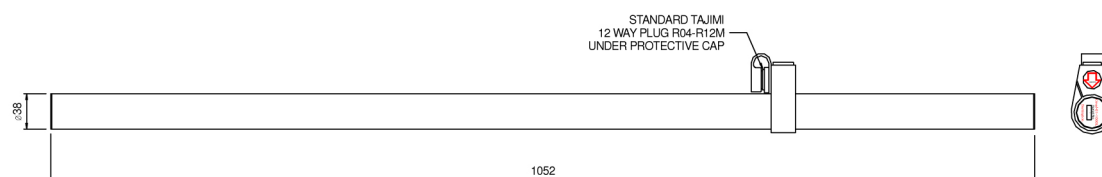


Figure 1. Grad-01-1000L outline drawing

## 4. Operation

The unit requires a power supply of 12V unregulated. The input is protected against reversed polarity. The analog output of  $\pm 4V$  full scale is referenced to power ground within the gradiometer. A separate signal ground connection permits the use of a differential input data logger for good noise immunity. The normal scale factor is  $\pm 100nT$  full scale but a high scale of  $\pm 1000nT$  can be selected by pulling input /HR to ground at any time. The analog output is active irrespective of the status of the other digital control lines. Enquiries are welcomed for suitable data loggers and power supplies.

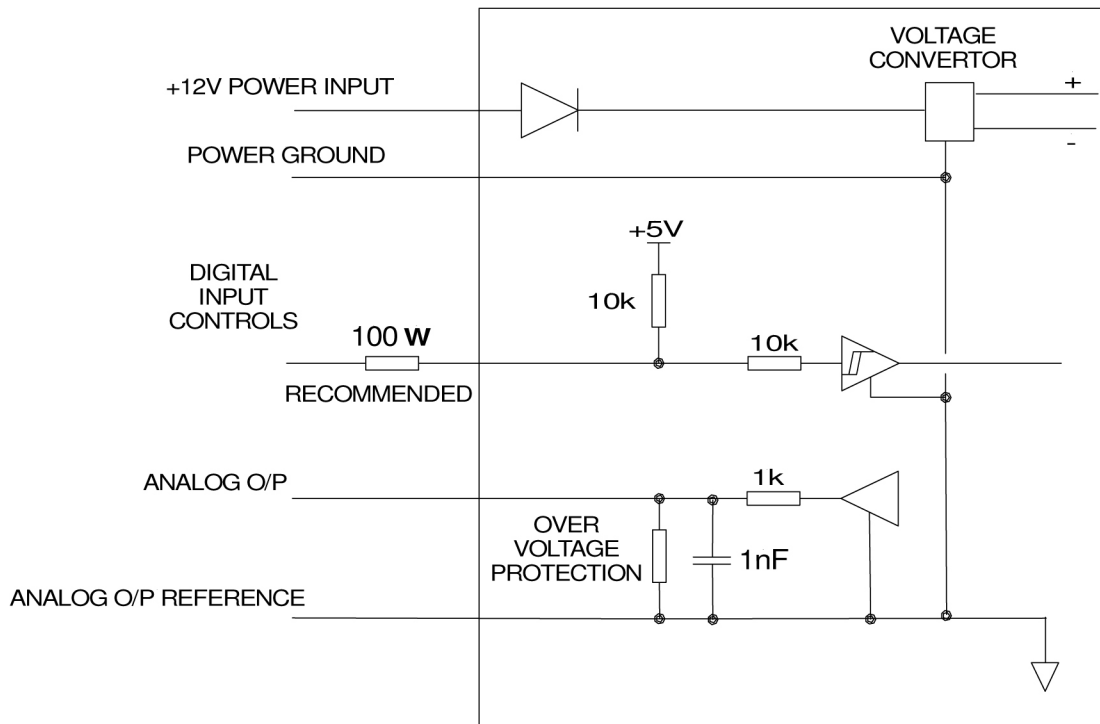


Figure 2. Electronic interface

## 5. Resolution Limit

The gradiometer output represents the difference between the outputs of the two sensors. The resolution of any fluxgate gradiometer is limited by small errors in offset, gain and angular alignment between these sensors. These errors appear in response to changes in the sensor orientation. The Grad-01-1000L has a digital interface to allow the user to minimise these errors. The errors are classified as follows:

Offset Error - O	This is the departure from zero output regardless of the orientation of the gradiometer.
Vertical Error - V	This error alternates in magnitude when the long axis of the gradiometer is alternately inverted and non-inverted. This error increases in significance as the inclination of the terrestrial field increases, that is, towards the poles.




North/South Error – N	This error is due to misalignment of the sensors in the direction of the arrow and therefore is discovered by pointing the arrow alternately north and south.
East/West Error – E	This error is due to misalignment of the sensors at right angles to the direction of the arrow and is discovered by pointing the arrow east and west.

## 6. Digital Adjustment

Compensation for the above errors is set using six CMOS/TTL inputs. The most recent settings are stored internally even with the power disconnected. They may be revised at any time whilst in use. The digital lines are active in the low state and are fitted with internal pull-up resistors. All lines are heavily protected against electrical damage and false operation. The lines are inhibited for a time of 2 seconds following power up. The lines operate as follows:

Device Select /DS	This line must be held low to select the gradiometer which is to be adjusted and held low during adjustment. Settings are stored when this line returns high but only if the /INC line is stable and high. A delay of 20mS must be allowed for the /DS line to stabilise after each level change.
Parameter Address Lines A, B, C	Three lines are used to address the relevant control within the gradiometer, as shown below.
Polarity POL	This line determines the polarity of the desired correction (increase or decrease).
Increment - /INC	Each time this line goes low the selected compensation setting is incremented one step to remove the error under investigation. A delay of 1mS must be allowed for the /INC line to stabilise after each level change.

Error Parameter Address Lines			
A	B	C	Function
H	H	H	Zero Offset fine Of
L	H	H	Zero Offset coarse Oc
H	L	H	Vertical fine Vf
L	L	H	Vertical coarse Vc
H	H	L	North/South fine Nf
L	H	L	North/South coarse Nc
H	L	L	East/West fine Ef
L	L	L	East/West coarse Ec

Parameter Adjustment			
/DS	/INC	POL	Mode
L		H	Step adjustment +ve direction
L		L	Step adjustment -ve direction
	H	X	Store current value

Digital Interface Timing		
Symbol	Parameter	Minimum ms
$t_{AC}$	Address stable to DS	0.5
$t_{CL}$	/DS to /INC setup	0.5
$t_{ID}$	/INC HIGH to POL Change	0.5
$t_{DI}$	POL to /INC Setup	0.5
$t_{IL}$	/INC LOW Period	0.5
$t_{IH}$	/INC HIGH Period	0.5
$t_{IC}$	/INC Inactive to /DS Inactive	0.5
$t_{CPH}$	/DS Deselect time	22
$t_{IW}$	/INC to output change	1
$t_{CYC}$	/INC Cycle time	0.5
$t_{R}, t_{F}$	/INC Input rise and fall time	1

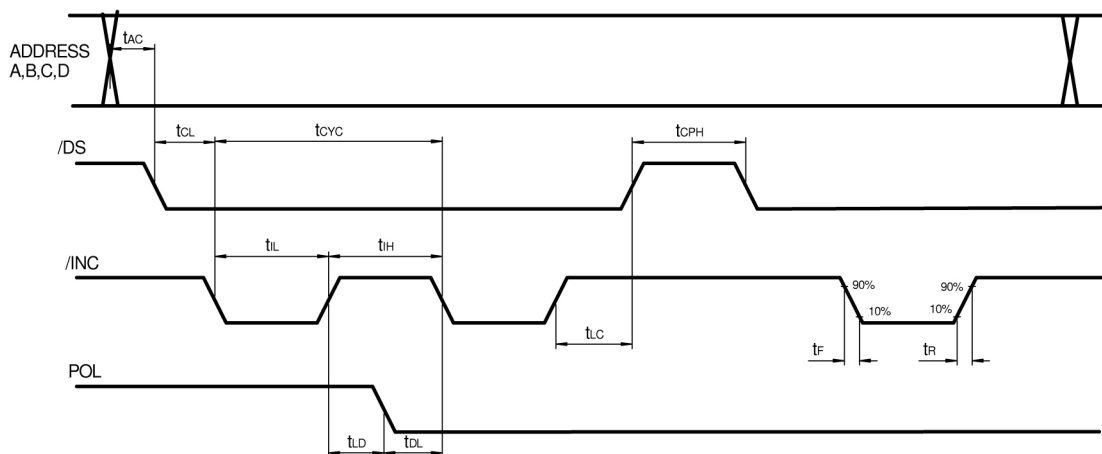


Figure 3. Digital interface timing.

## 7. Connector Cabling

See Figure 4. Electrical connection to the gradiometer is via a waterproof connector mounted on the side of the tube. The cable should be screened and the power conductors (pins A and B) should be a tightly twisted pair to minimise the production of stray magnetic fields. As a

precaution the cable should be immobilised relative to the gradiometer when in use. A mating connector can be supplied upon request.

Pin Connections		
Grad-01-1000L / Cable	Symbol	Function
A	Vs	V supply
B	Vso	Power ground (0V)
C	Va	Analog output ( 4V)
D	Vao	Analog output reference (0V)
E	/HR	Lo = High Range Select
F	/DS	Lo = Device Selected
G	Add A	Address A (LSB) Input
H	Add B	Address B Input
J	Add C	Address C (MSB) Input
K	POL	Direction of Setting Hi = positive
L	/INC	Incremental Setting
M		Shield

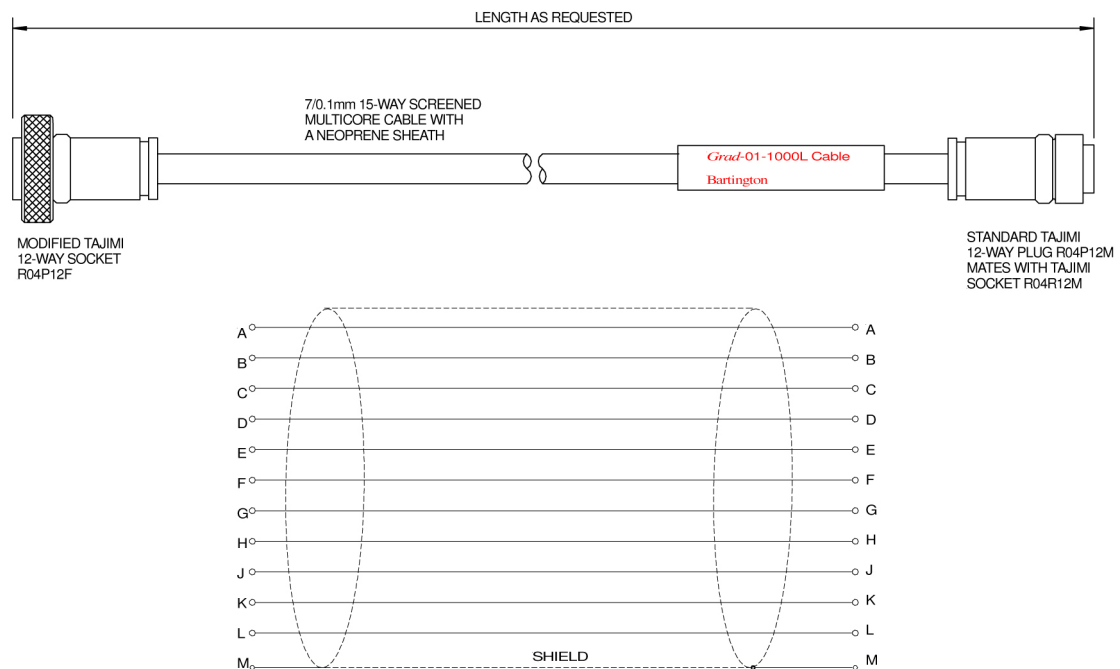


Figure 4. Cable drawing.

## 8. Mounting

The Gradiometer may be mounted using a suitable clamp at any point or points along the tube.

## 9. Troubleshooting

Much of this equipment is beyond the scope of normal service facilities. The sensor is not user serviceable. The most likely causes of failure, and their solutions, are detailed in the following table.

In the event of any apparent malfunction beyond those described in the table below, please email [service@bartington.com](mailto:service@bartington.com), or telephone the Bartington Instruments service team on +44 (0)1993 706565.

Cause	Solution
No operation	Check the power supply. If this is operating correctly then contact Bartington Instruments.
Damaged sensor	If any physical damage is apparent to the sensor then it may need to be replaced. For information about disposal of a damaged unit, refer to <a href="#">End of Life Disposal</a> .

## 10. Storage & Transport

The sensor is a precision electronic instrument and should be treated as such.

**Note:** Avoid exposing this instrument to shocks or continuous vibration.

**Note:** The sensor should be stored and transported in the original shipment packaging, or that of similar protective standard.



**Caution:** Do not expose this instrument to strong magnetic fields while being stored.



**Caution:** Take particular care when cleaning around electrical connections. Bent or damaged pins may cause the Grad-01-1000L to malfunction.

## 11. Environmental Precautions

Refer to DS0060 for maximum environmental ratings.



**Caution:** Exceeding the maximum environmental ratings may cause irreparable damage to the probe and electronics board.



## 12. End of Life Disposal



This product (electrical and electronic equipment) should not be placed in municipal waste. Check local regulations for disposal of electronic products.



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